Page 1, after the title, insert

--REFERENCE TO RELATED APPLICATION

This application is a divisional of application Serial No. 09/138,306 filed August 21, 1998.--now US. PAT. 6,185,078

In the Claims

Cancel claims 1-22 and 49.

Amend claims 23-48 as shown.

23. (Unchanged) A method of making a magnetic read head wherein the read head has a read region that has first and second sides that extend substantially perpendicular to the ABS, first and second end regions that are adjacent the first and second sides respectively and the read region and first and second end regions being adjacent the ABS, comprising:

forming a first shield layer;

forming an insulation layer on the first shield layer;

forming an antiferromagnetic oxide film on the insulation film;

forming a spin valve sensor with a non-magnetic layer directly on a first gap layer, the first gap layer comprising a bi-layer of said insulation film and said antiferromagnetic oxide film;

forming a mask on the spin valve sensor with first and second openings at first and second lead layer sites wherein the first and second openings define first and second side edges of a spin valve sensor to be located in the read region;

milling away spin valve sensor material in the first and second openings to expose the antiferromagnetic oxide film;

forming first and second lead layers on the antiferromagnetic oxide film in the first and second openings;

removing the mask;

forming a second gap layer on the spin valve sensor and the first and second lead layers; and

forming a second shield layer on the second gap layer.

24. (Unchanged) A method as claimed in claim 23 wherein the first and second lead layers have a ferromagnetic film formed directly on the antiferromagnetic oxide film in the first and second end regions respectively.

25. (Unchanged) A method as claimed in claim 24 wherein the spin valve sensor is formed in the presence of a magnetic field that is directed perpendicular to the ABS and the first and second lead layers are formed in the presence of a magnetic field that is directed parallel to the ABS.

26. (Unchanged) A method of making a magnetic read head wherein the read head has a read region that has first and second sides that extend substantially perpendicular to the ABS, first and second end regions that are adjacent the first and second sides respectively and the read region and first and second end regions being adjacent the ABS, comprising:

forming a first shield layer;

forming an insulation film on the first shield layer;

forming an antiferromagnetic oxide film on the insulation film;

forming a spin valve sensor on a first read gap layer which comprises bi-layer of said insulation film and said antiferromagnetic oxide film;

said forming of the spin valve sensor including:

forming a non-magnetic seed layer directly on the antiferromagnetic oxide film;

forming a ferromagnetic free layer on the non-magnetic seed layer;

forming a electrically conductive non-magnetic spacer layer on the free layer;

forming a ferromagnetic pinned layer on the electrically conductive non-magnetic spacer layer;

forming an antiferromagnetic metallic layer of Ni-Mn on the ferromagnetic pinned layer;

forming a cap layer on the antiferromagnetic metallic layer;

annealing the ferromagnetic pinned layer and the antiferromagnetic metallic layer of Ni-Mn at 240°-280° for 2-10 hours in a field that is directed transverse to the ABS;

forming a mask with first and second openings at the first and second end regions wherein the first and second openings define said first and second sides of the read region;

milling away the spin valve sensor within each of the first and second openings to expose the antiferromagnetic oxide film;

forming first and second lead layers on the antiferromagnetic oxide film in the first and second openings respectively; and

removing the mark;

milling away the cap layer and a portion of the antiferromagnetic metallic layer of the spin valve sensor and a portion of the cap layer of the first and second lead layers;

forming a second read gap layer on the antiferromagnetic metallic layer and on the first and second lead layers; and

forming a second shield layer on the second read gap layer.

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27. (Unchanged) A method as claimed in claim 26 wherein the antiferromagnetic oxide film is NiO.

28. (Unchanged) A method as claimed in claim 27 wherein the forming each of the first and second lead layers comprises:

forming a soft ferromagnetic film directly on the antiferromagnetic oxide film portion in a respective end region;

forming a non-magnetic adhesion film on a respective soft ferromagnetic film in a respective end region;

forming an electrically conductive non-magnetic film on a respective non-magnetic adhesion film in a respective end region; and

forming a non-magnetic cap layer on a respective electrically conductive non-magnetic film in a respective end region.

29. (Unchanged) A method as claimed in claim 28 wherein the first and second lead layers are formed in the presence of a field that is directed parallel to the ABS.

30. (Once Amended) A method of making a magnetic read head that has an air bearing surface (ABS), a read region that has first and second sides that extend substantially perpendicular to the ABS, first and second end regions that are adjacent the first and second sides respectively and the read region and first and second end regions being adjacent the ABS, comprising:

forming a read sensor in the read region with first and second side edges that define said first and second sides of the read region as follows:

forming a ferromagnetic free layer and a ferromagnetic pinned layer;

forming an electrically conductive non-magnetic spacer layer between the free and pinned layers;

forming an antiferromagnetic metallic layer that exchange couples to the pinned layer; and

forming a cap layer, on the antiferromagnetic metallic layer;

forming first and second lead layers in the first and second end regions with each lead layer having a first side edge wherein the first side edge of the first lead layer is adjacent the first side edge of the read sensor and the first side edge of the second lead layer is adjacent the second side edge of the read sensor;

forming first and second gap layers with each gap layer located in each of the read region and the first and second end regions;

forming the read sensor and the first and second gap layers between the first and second shield layers;

forming an antiferromagnetic oxide film between an insulation film and the first lead layer in the first end region, between the insulation film and the read sensor in the read region and between the insulation film and the second lead layer in the second end region with the first and second lead layers being exchange coupling to the antiferromagnetic oxide film and magnetostatically coupling to the read sensor; and

the forming of the read sensor locating the free layer between the antiferromagnetic oxide film and the pinned layer.

31. (Unchanged) A method as claimed in claim 30 including:

forming each of the first and second lead layers with a ferromagnetic film so that the ferromagnetic film of each of the first and second lead layers exchange couples to the antiferromagnetic oxide film in the first and second end regions respectively and magnetostatically couples the read sensor.

32. (Unchanged) A method as claimed in claim 31 wherein the making of each lead layer includes:

forming non-magnetic adhesion and cap films;

forming an electrically conductive non-magnetic film between the non-magnetic adhesion and cap films; and

in each of the first and second lead layers, forming the ferromagnetic film between the non-magnetic adhesion film and the antiferromagnetic oxide film in the first and second end regions, respectively.

33. (Unchanged) A method as claimed in claim 32 wherein the antiferromagnetic metallic layer is selected from the group Ir-Mn, Ni-Mn, Rh-Mn, Pt-Mn, Pd-Pt-Mn and Cr-Pt-Mn.

34. (Unchanged) A method as claimed in claim 32 wherein the antiferromagnetic oxide film is selected from the group NiO and α-Fe_2O_3.

35. (Unchanged) A method as claimed in claim 34 wherein the antiferromagnetic metallic layer is selected from the group Ir-Mn, Ni-Mn, Rh-Mn, Pt-Mn, Pd-Pt-Mn and Cr-Pt-Mn.

36. (Unchanged) A method as claimed in claim 32 wherein the non-magnetic seed layer is Ta, the free film is Ni-Fe, the spacer layer is Cu, the pinned layer is Co and the antiferromagnetic metallic layer is Ni-Mn.

37. (Unchanged) A method as claimed in claim 36 wherein the antiferromagnetic oxide film is selected from the group NiO and α-Fe_2O_3.

38. (Unchanged) A method as claimed in claim 32 wherein the antiferromagnetic oxide film is NiO and the ferromagnetic film of each of the first and second lead layers is Ni-Fe.

39. (Unchanged) A method as claimed in claim 32 wherein the second gap layer interfacially engages the antiferromagnetic metallic layer.

40. (Unchanged) A method as claimed in claim 39 wherein the antiferromagnetic metallic layer is Ni-Mn.

41. (Unchanged) A method as claimed in claim 40 wherein a thickness of the metallic antiferromagnetic layer is 15 - 25 nm.

42. (Unchanged) A method as claimed in claim 41 wherein the antiferromagnetic oxide film is NiO and the ferromagnetic film of each of the first and second lead layers is Ni-Fe.

43. (Once Amended) A method of making a merged magnetic head that has a read head and a write head wherein each head forms a portion of an air bearing surface (ABS) and the read head has a read region that has first and second sides that extend substantially perpendicular to the ABS, first and second end regions that are adjacent the first and second sides respectively and the read region and first and second end regions being adjacent the ABS, comprising:

making the read head as follows:

forming a multi-layered read sensor in the read region with first and second side edges that define said first and second sides of the read region, and with one of its layers being a non-magnetic layer;

forming first and second lead layers in the first and second end regions with each lead layer having a first side edge wherein the first side edge of the first lead layer is adjacent the first side edge of the read sensor and the first side edge of the second lead layer is adjacent the second side edge of the read sensor;

forming first and second insulation gap layers with each insulation gap layer located in each of the read and first and second end regions;

forming ferromagnetic first and second shield layers with the read sensor and the first and second insulation gap layers located between the first and second shield layers; and

forming an antiferromagnetic oxide film between the first insulation gap layer film and the first lead layer in the first end region, between the first insulation gap layer and the read sensor in the read region and between the first insulation gap layer and the second lead layer in the second end region with the first and second lead layers exchange coupling to the antiferromagnetic oxide film and magnetostatically coupling to the first and second side edges respectively of the read sensor; and

the forming of the read sensor forming the non-magnetic layer directly on the antiferromagnetic oxide film;

making the write head as follows:

employing the second shield layer as a first pole piece layer;

forming a second pole piece layer;

forming a write gap layer that separates the first and second pole pieces at the ABS;

connecting the first and second pole piece layers at a back gap;

forming an insulation stack with at least one coil layer embedded therein between the first and second pole piece layers and between the ABS and said back gap.

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44. (Unchanged) A method as claimed in claim 43 comprising:

making a read head as follows:

forming a ferromagnetic free layer and a ferromagnetic pinned layer;

forming an electrically conductive non-magnetic spacer layer between the free and pinned layers;

forming an antiferromagnetic metallic layer that exchange couples to the pinned layer; and

forming a cap layer;

forming each of the first and second lead layers with a ferromagnetic film so that the ferromagnetic film of each of the first and second lead layers exchange couples to the antiferromagnetic oxide film in the first and second end regions respectively and magnetostatically couples to the first and second side edges respectively of the read sensor;

forming non-magnetic adhesion and cap films;

forming an electrically conductive non-magnetic film between the non-magnetic adhesion and cap films; and

in each of the first and second lead layers, forming the ferromagnetic film between the non-magnetic adhesion film and the antiferromagnetic oxide film.

45. (Unchanged) A method as claimed in claim 44 wherein the antiferromagnetic oxide film is selected from the group NiO and α-Fe_2O_3.

46. (Unchanged) A method as claimed in claim 45 wherein the antiferromagnetic metallic layer is selected from the group Ir-Mn, Ni-Mn, Rh-Mn, Pt-Mn, Pd-Pt-Mn and Cr-Pt-Mn.

47. (Unchanged) A method as claimed in claim 44 wherein:

the second gap layer interfacially engages the antiferromagnetic metallic layer; and

the antiferromagnetic metallic layer is Ni-Mn.

48. (Unchanged) A method as claimed in claim 47 wherein:

a thickness of the antiferromagnetic metallic layer is 15 - 25 nm; and

the antiferromagnetic oxide film is NiO and the ferromagnetic film of each of the first and second lead layers is Ni-Fe.

Add new claim 50 as follows.

50. (New) A method of making a spin valve (SV) sensor having first and second end regions separated from each other by a central region, comprising the steps of:

forming a ferromagnetic free layer, a ferromagnetic pinned layer and a non-magnetic electrically conductive spacer layer in the central region with the spacer layer further located between the free layer and the pinned layer;

forming first and second lead layers in the first and second end regions;

forming a continuous antiferromagnetic oxide layer in the first and second end regions and the central region and exchange coupled to the first and second lead layers in the first and second end regions with the first and second lead layers magnetostatically coupled to the free layer for stabilizing the free layer; and

forming a non-magnetic spacer layer between and interfacing each of the oxide layers and the free layer for preventing an exchange coupling therebetween.

In the Abstract

Page 44, lines 1-2, delete the title "SPIN VALVE READ HEAD WITH ANTIFERROMAGNETIC OXIDE FILM AS LONGITUDINAL BIAS LAYER AND PORTION OF FIRST READ GAP" and insert new title --METHOD OF MAKING A SPIN VALVE READ HEAD WITH ANTIFERROMAGNETIC OXIDE FILM AS LONGITUDINAL BIAS LAYER AND PORTION OF FIRST READ GAP--.

Page 44, line 10, delete "film" and substitute therefor --films-- .

line 11, delete "couples" and substitute therefor --couple-- .